

**Part 1. Report Cover**

**Report Number:** DLAF040

**Report Date:** 2 August 02

**Title:** Performance Oriented Packaging Testing of a  
Grade V3c, Fiberboard Box, Style RSC, 8" x 8" x 12" (ID),  
with one Gallon, Round, Plastic Bottle (Qty of 1) for Liquids.  
Surface Shipment Only.

**Responsible Individual:** Francis S. Flynn

**Performing Activity:** LOGSA Packaging, Storage,  
and Containerization Center  
ATTN: AMXLS-AT  
11 Hap Arnold Boulevard  
Tobyhanna, PA 18466-5097

**Performing Activity's Reference(s):** TT 10-02; 9HTNR; AMC 13-88

**DTIC Distribution:** N/A

**Requesting Organization:**  
Defense Logistics Agency  
Defense Distribution Center  
ATTN DDC J-3/J-4-0  
2001 Mission Drive  
New Cumberland PA 17070-5000

**Requesting Organization's Reference(s):**  
DLA Memo, 27 Nov 01

**Test Results:**   \_\_\_ single   X combination   \_\_\_ composite

**Section I. Pre-test Conditions**

The following identification schema designates the packaging specimen used for the test(s) indicated.

<u>Specimen No.</u>	<u>Test</u>
A	stack test
A	repetitive-shock vibration test
A	flat onto bottom, drop test
	flat onto long side, drop test
	flat onto top, drop test
	flat onto short side, drop test
	bottom corner, drop test
B	water resistance test

**Section II. Summary**

<b>A. Drop test</b>	<b>PASS</b>
<b>B. Leakproofness test</b>	N/A
<b>C. Internal pressure test/Hydrostatic pressure test</b>	N/A
<b>D. Stacking test</b>	<b>PASS</b>
<b>E. Vibration standard</b>	<b>PASS</b>
<b>F. Water resistance test</b>	<b>PASS</b>
<b>G. Compatibility test</b>	N/A

## Test Results (continued)

### Section III. Discussion

#### A. Drop test: 49 CFR §178.603

Test date(s): 6/17/02

☒ cold conditioned (0° F, 72 hr)  
☐ ambient conditions ( ~72° F )  
☐ standard conditions (50% RH & 23° C)

No.	Ht.	Orientation	Results
A	71 "	Flat onto box bottom (3)	Pass/No leaks/rupture; entire contents retained
A	71 "	Flat onto box long side (4)	Pass/No leaks/rupture; entire contents retained
A	71 "	Flat onto box top (1)	Pass/No leaks/rupture; entire contents retained
A	71 "	Flat onto box short side (6)	Pass/No leaks/rupture; entire contents retained
A	71 "	Diagonally onto bottom joint corner (5-2-3)	Pass/No leaks/rupture; minor crushing of the 5-2-3 corner; contents retained completely within the box

Specimen A, a combination packaging consisting of a grade V3c fiberboard box (outer packaging) containing one 1-gallon, round, plastic bottle (inner packaging/article). The plastic bottle was filled with propylene glycol to 98% of maximum capacity (based on weight). Upon examining the box, there was no leakage, rupture, or damage noted, except for minor crushing of the 5-2-3 corner. The bottle was retained completely within the box.

In conducting the drop test, all five drops (flat bottom, flat long side, flat top, flat short side, and bottom corner) were performed on the same configuration. The decision to use the same container (configuration) for all five drop orientations was based on the relatively minimal damage demonstrated during previous testing of grade V3C, fiberboard boxes with different inner containers or articles. Five drops per configuration exceeds 49 CFR §178.603 requirements, as well as both UN and ASTM recommendations (i.e., one drop on a side or corner per box). The use of one configuration for multiple tests and drops is DOD policy as stated in DLAD 4145.41/AR 700-143/AFJI 24-201/NAVSUPINST 4030.55A/MCO 4030.40A, Packaging of Hazardous Material. Also per this policy, any failed orientation(s) can be repeated using another configuration.

#### B. Leakproofness test: 49 CFR §178.604

N/A. The leakproofness test was not conducted on the box, because the packaging is not intended for the containment of liquids.

#### C. Internal Pressure/Hydrostatic Pressure test: 49 CFR §178.605

N/A. Testing for the maintenance of internal pressure is not required for this configuration.

**Test Results: Section III** (continued)

**D. Stacking test:** 49 CFR §178.606

**Test date(s):** 5/16/02

☐ standard conditions (23° C & 50% RH)

☒ ambient conditions ( ~72° F )

☐ high temperature conditions (104° F)

No.	Length	Type	Load/Force Required	Peak Force	Results	Stability Maintained?
A	24 hr	Static	294 lb	N/A lbf	Pass	Yes

A static top load was used for the stack test, because it could hold the load constant for the required 24-hour timeframe. The total top load applied on the empty box was greater than the minimum required for one box based on the outside box height and the gross packaged weight. The top load was to simulate a stack of identical packagings that might be stacked on the packaging during transport.

**E. Vibration test:** See 49 CFR §178.608.

**Test date(s):** 6/17/02

No.	Frequency	Duration	Results
A	2.63 Hz	1 hr	Pass. No leakage, rupture, or damage

To be in compliance with U.S. Department of Transportation standards for packagings bearing the United States mark (USA) as a component of the packaging certification marking (49 CFR §173.24a(a)(5)), the vibration test was performed, as a means to determine capability. The test was conducted as prescribed by ASTM D 999, method A2 (Repetitive Shock Test (Rotary Motion)). The test was run for 1 hour, using the fiberboard box packaging. The packaging was tested using a 1,250-lb vibration table (rotary motion) that had a 1-inch vertical double amplitude (peak-to-peak displacement) such that the packaging was raised from the platform to such a degree that a piece of steel strapping (1.6 mm) could be passed between the bottom of the package and the platform.

**F. Water resistance (Cobb Method) test** (fiberboard): 49 CFR §178.516  
As required by the standards for fiberboard boxes, the Cobb Method Test for water absorptiveness was performed on a specimen cut from one box (DLAF037).

**Test date(s):** 4/3/02

No. specimens felt side (exterior) 5. Average 115 g/m<sup>2</sup>. Highest exterior value was 124 g/m<sup>2</sup>. Lowest exterior value was 111 g/m<sup>2</sup>. All of the samples tested were free of printing.

No. specimens wire side (interior) 5. Average 117 g/m<sup>2</sup>. Highest interior value was 120 g/m<sup>2</sup>. Lowest interior value was 114 g/m<sup>2</sup>.

No. specimens exceeding 155 g/m<sup>2</sup> 0.

**Test Results: Section III (continued)**

It should be noted that improper storage and rough handling could break the fibers and abrade the coating of the box, decreasing its ability to resist water absorption. This could result in higher test values. Since commercial boxes are occasionally made with the wire facing (interior) as the exterior side of the box, specimens from both the wire (interior) and the felt (exterior) facings should be tested for water absorptiveness.

**G. Compatibility test** (plastics packagings only): N/A.

**Test Personnel**

The following personnel performed the aforementioned testing, or had a role in the testing, evaluation, and/or documentation, as reported herein-- Richard D. LaFave, Bruce W. Samson, Timothy L. Reimann, and Karen K. Kimsey

**References**

**A. Title 49 Code of Federal Regulations, Parts 106-180,** Winter 2002, current as of 15 Oct 02

**B. International Air Transport Association Dangerous Goods Regulations,** 40th edition, 1 January 1999

**C. ASTM D 4919,** Specification for Testing of Hazardous Materials Packagings.

**D. ASTM D 999,** Standard Method for Vibration Testing of Shipping Containers.

**E. ASTM D 951,** Standard Test Method Water Resistance of Shipping Containers by Spray Method.

**F. TAPPI Standard: T 441** Water Absorptiveness of Sized (Non-Bibulous) Paper and Paperboard (Cobb Test).

**G. Recommendations on the Transport of Dangerous Goods,** sixth revised edition, United Nations, New York, 1990.

**H. DLAD 4145.41/AR 700-143/AFJI 24-201/NAVSUPINST 4030.55A/MCO 4030.40A,** Packaging of Hazardous Material, 23 Jul 96

**I. AFJMAN 24-204/TM 38-250/NAVSUP PUB 505/MCO P4030.19G/DLAI4145.3,** Preparing Hazardous Materials for Military Air Shipments, 1 Mar 97

**Test Results: Section III (continued)**

**Equipment**

<b>Item</b>	<b>Manufacturer</b>	<b>Serial No.</b>	<b>Calibration Expiration Date</b>
1,250-lb vibration table	L.A.B Skaneateles, NY	8120179	<i>see note</i>
5,000-lb compression tester	L.A.B Skaneateles, NY	1107050	4/03
drop tester	Lansmont Monterey, CA	M12906	N/R
Cobb Sizing Tester	Teledyne Curley Troy, NY	4180-A	N/R
cold chamber	Russells Holland, MI	1962214	4/03

Note. Equipment is calibrated in accordance with International Safe Transit Association test equipment verification requirements.

## **Appendix A**

### **Test Applicability**

Pass/fail conclusions were based on the particular fiberboard box specimens, test loads, and the limited quantities submitted for test. Extrapolation to other materials, other manufacturers, other applications, different inner packagings, container sizes, or lesser inner quantities is the responsibility of the packaging design agency or applicable higher headquarters. Extrapolation of test results based on less than the minimum recommended number of test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.

Testing was performed per *Title 49* Code of Federal Regulations.

Performance testing was undertaken and completed at the request of an agency responsible for shipment of the dangerous good(s). The completion of successful required performance tests does not, by itself, authorize the marking and transportation of the dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).

The required performance tests are intended to evaluate the performance of the packaging components. The criteria used to evaluate packaging performance is whether the contents of the packaging are retained within the outer packaging, should damage to the outer packaging occur, and secondly, if any inner packaging of hazardous materials leaks, ruptures, or is damaged so as to affect transportation safety. The successful completion of the required tests does not ensure the undamaged delivery or survivability of the actual commodity/item. Separate testing is necessary to assure the stability of any explosive item.

Before a configuration can be certified by the person(s) authorizing shipment, the appropriate packaging for the particular hazardous materials and mode of transportation must be determined, and the item(s) must be prepared for shipment per applicable regulations. The chosen configuration must have been performance tested in accordance with the size, the shape, and the weight constraints posed by the configuration to be certified. The testing reported herein should not be construed as blanket certification of any configuration that simply uses the performance tested outer fiberboard box. Packaging paragraphs apply.

## Appendix B

### Test Data Sheet

#### Section I. Test Product

**Physical State:**           solid      X   liquid           gas           aerosol

Name:    Water

Amount Per Container (Configuration):

1-gallon, rated; 8.3 lb; 8.57 lb, packed

Gross Weight:    12.80 lb

#### Section II. Test Parameters

**Drop Height:**    Ref:    49 CFR §178.603

       1.8 m; 71 in. (PG I, II, & III, SG ≤1.2 or solids)

       1.2 m; 47 in. (PG II & III, SG ≤1.2 or solids)

       0.8 m; 32 in. (PG III, SG ≤1.2 or solids)

  X   from--                      PG I:    SG x 1.5 m x 59.06 in./m

       **71 in.**                      **PG II:    1.8 (SG) x 1.0 m x 39.37 in./m**

                            PG III:    SG x 0.67 m x 26.38 in./m

#### Stacking Weight Formula, Liquids - DLA

Variables	Inputs			
h    height, drum/box	12.5			
n    # stacked containers	XXXXXXXX	9.44		
w1   weight, drum/box	1.15			
w2   weight, bottle/can	0.27			
w3   weight, ring/pad	3.08			
q1   # inner containers	1			
v1   max. volume, 1 inner container	1			
v    total volume	XXXXXXXX	1		
w4   weight, item (unpacked)	8.3			
W5   weight, absorbent	0			
W    total weight	XXXXXXXX	12.8		
C    constant	1			
A1   Stacking weight-PG I	XXXXXXXX	<b>190.4</b>	<b>191</b>	
A2   Stacking weight-PG II	XXXXXXXX	<b>231.6</b>	<b>232</b>	
A3   Stacking weight-PG III	XXXXXXXX	<b>293.4</b>	<b>294</b>	

**NOTE:**    A1 = (n-1)\*(w+(1.2\*v\*8.3\*0.98))\*(c), Packing Group I  
               A2 = (n-1)\*(w+(1.8\*v\*8.3\*0.98))\*(c), Packing Group II  
               A3 = (n-1)\*(w+(2.7\*v\*8.3\*0.98))\*(c), Packing Group III

A1 = stacking weight in pounds, PG I

A2 = stacking weight in pounds, PG II

A3 = stacking weight in pounds, PG III

n = (118/h), minimum number of containers that when stacked, reach a height of 3 m

w = w1+(w2\*q1)\*(w3\*q1)\*w5, total weight in pounds

v = v1\*q1, total volume

C = either 1.5 (the compensation factor that converts the static load of the stacking test into a load suitable for dynamic compression testing), or 1.0 (static top load)



## Appendix B (Continued)

### Section III. Equivalencies of Liquids

	Specific Gravity <sup>1</sup>	Total (Each) Amount per Container	Gross Weight (pounds) (kilograms)	
water*	1.0	8.30 lb	12.80	5.80
PG I	1.2	10.00 lb	13.08	5.93
PG II	1.8	14.94 lb	18.02	8.17
PG III	2.7	22.41 lb	25.49	11.56

Note 1. Equivalent specific gravity derived from drop height as follows-- PG factor x density (or SG) = drop height, thus

SG = drop height/PG factor (49 CFR §178.603)

PG I: 1.5 m x SG = 1.8 m, thus SG = 1.2

PG II: 1.0 m x SG = 1.8 m, thus SG = 1.8

PG III: 0.67 m x SG = 1.8 m, thus SG = 2.7

Unless otherwise computed for more dense liquids, water (SG = 1) represents a solution having a specific gravity of 1.2 or less.

## Appendix C

### Packaging Data Sheet

#### Section I. Exterior Shipping Container

Packaging Category: \_\_\_\_ single X combination \_\_\_\_ composite

UN Type: Fiberboard boxes (49 CFR §178.516) UN Code: 4G

Specification No.: ASTM-D5118; Style RSC; 1.15 lbs.;  
8" x 8" x 12" (ID); 8½" x 8½" x 12½" (OD)

Manufacturer: Packaging Control Corp., York, PA 17402

Date(s) of Manufacture: February 2002

Closure Method: The fiberboard box was sealed (7 strip method) using 2" A-A-1830 clear tape. (See drawing)

#### Additional Description:

a. Fiberboard pads (c flute, 200 Burst), were first placed in the box on all sides and the box bottom. Approximate sizes of the top and bottom pads were 7.5 x 7.5 inches. Three side pads were approximately 7.5 x 11.0 inches and three side pads were 6.0 x 11.0 inches. The 1-gallon bottle was first placed in a 18 x 30 inch, 4-mil, polyethylene bag and then placed on the bottom pad. The top pad was placed on the bag enclosed plastic bottle and the box was sealed using the closure method described above.

Bag Manufacturer: Quality Packaging Systems of Warren, Inc.,  
24260-2 Mound Road, Warren, MI 48091-5324

## Appendix C (Continued)

## Section II. Inner Packaging/Article

Quantity of Inner Containers: 1                      Capacity: 1-gallon

Specification Type and No(s) .: N/A

Type: round, clear, plastic, screw-cap bottle with handle

Manufacturer/Distributor: Freund Can Company, Chicago, IL

[illegible]

Tare Weight (empty): 0.27 lb

Dimensions: 6¼ in. - diameter (OD)  
11¾ in. - height (OD)

Closure Type: Plastic screw cap

Secondary Closure: Filament reinforced tape (1 piece)

Secondary Closure Specification:

Secondary Closure Manufacturer and Part No.:

## Appendix D

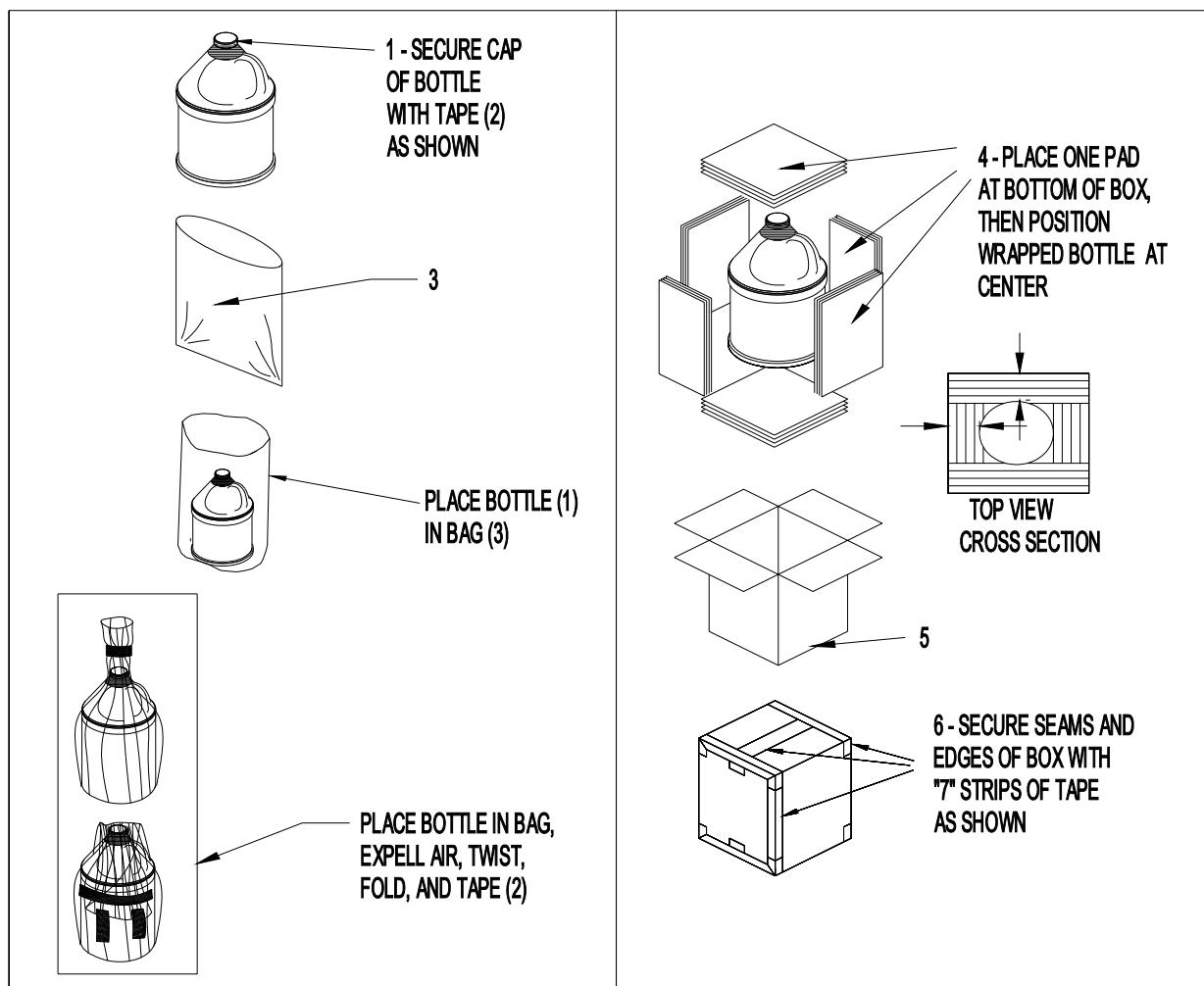
### Rationale

The equivalent of Packing Group II & III testing was requested for a 8- by 8- by 12-inch corrugated fiberboard box having as the intended contents one 1-gallon, round, plastic bottle with a screw cap. The configuration to be tested is intended to be applicable to a large assortment of liquid products contained in 1-gallon bottles. For lesser volumes, variations to testing requirements can be found in 49 *CFR §178.601(g)*.

Propylene glycol was used as the test liquid as permitted by Title 49 Code of Federal Regulations (CFR). Substitution for the actual hazardous lading is permitted by 49 *CFR §178.602(c)*.

One combination packaging made to the above described configuration was subjected to drop and vibration testing as prescribed in ASTM D 4919. These tests are designed to simulate the shock and vibration a package (configuration) may encounter when being shipped worldwide by truck, rail, or ocean going transport. The order of testing was vibration, then drop testing. Prior to the rough handling testing of the packed box, static loading was performed on an empty box. This is a U.S. DOT approved method of stack testing, especially when the combination packaging has wide applications. A separate box was used for water absorptiveness testing of the fiberboard.

**Appendix D (Continued)**  
**Drawing**



ITEM	DESCRIPTION	DLA02040
1	1-GALLON, ROUND PLASTIC BOTTLE WITH CAP, QTY. 1	
2	1-INCH WIDE, PRESSURE-SENSITIVE TAPE, FILAMENT-REINFORCED, IAW ASTM D5330, TY II	
3	4-MIL POLYETHYLENE BAG	
4	FIBERBOARD PADS (C FLUTE, 200 BURST), APPROXIMATE SIZES 7.5 X 7.5, 7.5 X 11.0, 6.0 X 11.0 IN.	
5	FIBERBOARD BOX, ASTM D5118, STYLE RSC, GRADE V3c, NSN: 8115-00-281-3882, 8 X 8 X 12 IN.	
6	2-INCH WIDE, PRESSURE-SENSITIVE TAPE, IAW ASTM D 5486, TY II, NSN: 7510-00-266-6715	

**Appendix D** (Continued)



**Appendix D** (Continued)

